

A third solution to the manipulation and default problem (and recommended by Nalebuff and Bulow for other reasons as well) would be for the Commission to adopt a variation of the open English auction called the "Japanese Auction."

Here, bidders raise their hands initially, and keep them raised, while the auctioneer raises the bidding by pre-specified increments. Bidders drop out by lowering their hands as the price ascends beyond what they are willing to pay, and they may not re-enter the bidding once their hands are dropped. Bidding escalates until only the winning bidder(s) remains.<sup>54/</sup>

As the Nalebuff/Bulow Paper explains, a Japanese auction run in this fashion not only helps prevent parties from blocking others from bidding by rapidly escalating the bids, but has the added advantage of reducing the so-called "winner's curse."<sup>55/</sup> This is because bidders have more information than they do in any open English auction about how many bidders remain in the competition. Theoretical auction literature predicts that prices will go slightly higher in a Japanese auction (with more information there is less concern about the winner's curse, and more incentive to bid aggressively), but the structure of the auctions eliminates the possibility of someone jumping in with a wildly irrational bid that could be more likely to yield a default.<sup>56/</sup>

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<sup>54/</sup> Id. at 11-12.

<sup>55/</sup> When the market value of an object is uncertain, each bidder must estimate the object's true worth. In the presence of such uncertainty, auction theory indicates that, on average, the highest estimate will be too high. Thus, if the bidder with the highest estimate of the value of the object offers the winning bid for it, this bid will, on average, also be too high. Economists call this phenomenon the "winner's curse." See CBO Study at 45; Nalebuff/Bulow Paper at 12, 16 (Appendix A).

<sup>56/</sup> Id. at 12-13. Another advantage of a Japanese auction is that it makes it easier to implement Bell Atlantic's proposal to auction the two 30 MHz MTA licenses in one consolidated auction. Id.

## V. OTHER AUCTION ISSUES

### A. Mutually Exclusive Cellular Unserved Area Applications Should Be Subject to Competitive Bidding Procedures

The Commission is granted the option under the Budget Act to allow a large number of mutually exclusive unserved area applications filed prior to July 26, 1993, to be resolved by auction rather than by lottery. The Commission has decided to use competitive bidding authority to resolve these applications. Bell Atlantic supports this decision.

As the Commission observes, auctioning these licenses will provide the opportunity for a wider variety of applicants to become cellular licensees.<sup>57/</sup> The use of auctions also will discourage the participation of speculators who do not intend to build out unserved areas, thus promoting more rapid service to the public, and particularly to rural areas.<sup>58/</sup>

Bell Atlantic recommends that the Commission adopt an open auction as the specific mechanism to choose among mutually exclusive unserved area applications, and agrees that the pool of bidders should be limited to those applicants who filed prior to July 26, 1993. These applicants have already expended the time and resources to apply to enter the process, and given the large number of applications on file, there is little to be gained in terms of either fairness or administrative efficiency by re-opening the applications process.

Finally, the Commission should allow full market settlements in the markets at issue pending the decision of auctions or lotteries. Service to these areas has been delayed for too long already. Allowing parties the chance to resolve directly their potentially

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<sup>57/</sup> Auction Notice at 54, ¶ 160.

<sup>58/</sup> See id.

conflicting applications without expending further resources in administrative processes can only speed deployment of cellular service to unserved areas in accordance with the Commission's goals.


## VI. CONCLUSION

The Commission's use of competitive bidding will be of immense benefit to American consumers if the Commission succeeds in designing workable auctions that fairly and efficiently allocate licensed spectrum. While the Commission's PCS rules must be changed to allow all qualified entities to participate, the Commission should in any event maximize bidder participation in the PCS auctions, and should simplify the design of the auctions in the manner proposed.

Respectfully submitted,

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November 10, 1993



# Designing the PCS Auction

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## Introduction

The following comments are our expert opinions regarding how auction theory and game theory can inform the practical problems in designing the PCS spectrum auction.

We want to begin with what may seem to be a curious statement of principle coming from experts on game theory and strategic analysis: "Our goal in suggesting design modifications to the PCS license auction is to eliminate wherever possible the role of strategy." The auction will work best if the design minimizes the strategic element of bidding. The reason for this approach is equally simple: We believe that the auction should be won by the bidder who has the highest valuation for the license, not the person with the cleverest bidding strategy. Because of our focus on the strategic angle to each situation, we believe that the suggestions below will help frustrate those who hope to win by gaming the auction and will benefit those who will bring the highest value to this new PCS technology.

Let us give an example of the insight from this approach. Bidding in an open ascending-bid (English) auction requires less strategic analysis than participating in a first-price sealed-bid auction. (For a background on the different types of auctions, see Appendix A.) In the English auction, the optimal strategy is to bid until the price exceeds your valuation.<sup>1</sup> You need not consider how others will act. In contrast, when placing a sealed bid, you must consider how everyone else will act in order to determine your optimal strategy. Because of the need for strategy, it is possible that the person with the truly highest value will not win the auction in sealed bidding. This is never an issue with an open English auction. A person with the highest value for the object will never fail to win the auction because of a poor or unlucky bidding strategy.

We now turn to consider the PCS auction. The problem of designing an auction for seven spectrum bands and 49 MTAs and 488 BTAs is an enormously complex task. The FCC has done a remarkable job in getting the auction design off on the right foot. The proposals below are suggestions that we believe will help ensure that the auction mechanism achieves its intended result: a fair, efficient and rapid allocation of PCS spectrum.

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<sup>1</sup> This valuation may be influenced by how high other people are willing to bid.

There are five principles that we believe should guide the auction design.

- 1. Simplicity;**
- 2. Fairness;**
- 3. Efficiency;**
- 4. Increase Information, Discourage Irrationality; and**
- 5. Eliminate Incentive to Manipulate Bidding or Default.**

### **1. Simplicity**

#### ***Simplicity is a Virtue***

Bidders must understand the rules of the auction. If the rules are very complicated or even a little complicated, participants may get confused and the results of the auction become unpredictable. We do not want to create a system that will lead people to overbid and then either have an incentive to default or end up insolvent and thereby delay the implementation of this technology. Nor do we want to artificially depress the bidding because firms do not understand the rules.

Later in this document, Appendix B, we provide a detailed discussion of the efficient auction mechanism, one that is designed to handle combinatorial bidding and eliminate the role of strategic bidding. But we do not recommend this scheme. It is too complicated, especially given the scale, novelty, and uncertainty associated with the PCS auction. Our proposal can be thought of as an auction design that retains many of the theoretical advantages and yet is also simple.

Even the FCC's current proposed design may tax the decision-making abilities of firms that are interested in participating in a large number of the bidding competitions. For example, because of the sequential nature of the proposed bidding and the different auctions for each frequency block, firms will need to prepare extensive conditional

bidding strategies. Consider the sequential auction of the two 30 MHz licenses. How much people are willing to bid for block B will depend on who won block A and how much they paid.

Preparing different bids for each of the frequency blocks is a complicated engineering task. Firms will have to invest significant resources in valuing the different incumbency effects. If the auctions are to be held in sequence, each party should prepare a bid contingent on who won the other license(s) in that region. This complexity will disadvantage firms that are interested in bidding for multiple 30 MHz MTA licenses or a network of 10 MHz BTA licenses. Running seven auctions is also unnecessary work for the FCC. The same objectives can be accomplished with only four auctions.

**Proposal 1.** Have one auction for the two 30 MHz licenses, one auction for three of the 10 MHz licenses and then two auctions for the remaining 20 MHz and 10 MHz preferred licenses.

• For the two 30 MHz bandwidths, the top two bidders would each win a license. The higher of the two bidders gets first choice. (Thus the second highest bidder might want to raise his or her bid in order to be the highest bidder.) For the 10 MHz bandwidths, the top three bidders would each be awarded a license, with the highest bidders getting first choice.<sup>2</sup>

The theoretical result from auctions literature predicts that selling two identical products sequentially yields the same expected revenue as selling them simultaneously. In the case of sequential auctions, each should have the same price. Otherwise, a firm would choose to wait for the second auction if it was thought to have the lower price or bid higher in the first round if that was perceived to be the better deal.<sup>3</sup> Since selling them sequentially or simultaneously has the same expected revenue, why should we prefer one approach over the other?

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<sup>2</sup> Note that we are only combining three of the four 10 MHz bandwidths. The reason is that one of the bandwidths is currently designated for preferential bidders.

<sup>3</sup> This proposition has been investigated on an empirical level in the wine market by Ashenfelter (1989).



First, it is administratively simpler to run one auction rather than two in the case of the 30 MHz licenses and it is simpler to run one auction rather than three in the case of the non-preferential 10 MHz licenses.

There is also a compelling efficiency justification for running one auction rather than two in sequence. *When there is only one auction, the two highest bidders will always win.* Since we believe that bids are positively correlated with valuations, that means that the licenses will always go to the two firms with the highest values. In contrast, when the auctions are run in sequence, it is possible that someone other than the top two bidders might win the first auction. In the first auction, the “true” top two bidders each mistakenly think that they are the only other person who values the license at the winning price. As a result, in the second auction, the price goes much higher and one of the efficient firms fails to get a license.

The culprit is bidding complexity and the role of strategic bidding. When there are two auctions, you have to develop a strategy for bidding in the first versus second auction. With only one auction, you don’t have to consider this issue and there is no room to outsmart yourself. By eliminating the need for strategic bidding, we also eliminate the possibility of having an inefficient auction outcome. To go back to the underlying principle, when two (or more) identical items are sold in sequence, you have to game your bidding strategy across the auctions; when the auctions are combined, there is no need to game the bidding. *With one auction, the highest bidders win, period.*

Economic theory is often criticized because it does not take account of practical realities. The above results are based on the presumption that the A and B bands are identical.<sup>4</sup> In practice, the PCS auction departs from this theory in three ways. First, the units are not quite identical. There are incumbency effects stemming from the lingering presence of fixed microwave users in the PCS bands: thus some frequencies are worth more than others. Second, there is limited ability to process information among the bidders and this may lead to departures from rational or optimal bidding. Third, we need to consider how combining the regional licenses into one auction will affect the possibility for combinatorial bidding, in particular, bidding for a national license. Taking account of these three factors does not change the basic conclusion.

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<sup>4</sup> Similarly, that the D, E, and F bands are identical. We will continue to focus on the 30 MHz band in our text and the 10 MHz auction follows a parallel argument.

First, even though the licenses will have slightly different values, bidders will agree which is the better license. The difference is primarily due to the cost of moving incumbents. Everyone will prefer the license with less interference.<sup>5</sup> The proposed design still allows firms to bid more for the preferred license since the top bidder gets first choice.<sup>6</sup>

It is also easier to develop a strategy for how much you are willing to bid for a license not knowing the identity of the other winner. This substitutes a little bit of risk for decision-making capabilities. For most licenses, the differences in values based on the identity of the other winner is likely to be small and therefore the risk is correspondingly small. Moreover, there is no reason to trade because the cost of moving incumbents will be similar for all participants. We believe that bidders will be better able to handle a small amount of risk than develop conditional strategies for the B band based on the price and winner of the A band. The decision-making ability of participants will already be sorely taxed. Bidding in one auction is simpler and quicker. It will prevent the need to game the bidding in deciding whether to bid more aggressively in the first versus second auction.

Combining the regional auctions also makes the combinatorial bidding simpler. Consider the bidding for a national license. Instead of two sealed bids, one for the A license and one for the B license, firms make only one sealed bid. After the regional bidding is over, the FCC would evaluate the national bids. Two national licenses would be awarded if and

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<sup>5</sup> There is the technical issue of whether a firm that wants to form a regional or national network needs to have the same band in each region. Discussions with Bell Atlantic engineers suggest that headsets are able to scan the two spectrum bands and therefore firms can build a network combining A and B licenses. Thus it is not necessary to bid on only the A or B frequencies. Similarly, the 10 MHz frequencies can be patched together.

<sup>6</sup> Bidding for first and second place creates one element of complication in the bidding. We discuss this issue only briefly because the complication does not arise if we also move to the recommended Japanese style bidding (see discussion below). The issue is as follows: if the two highest bids are currently 50 and 60, then we must allow firms to bid anything above the second highest bid, 50. Thus the auctioneer must keep track of the two highest bids, not just one. In the English auction, the auctioneer would close the bidding by asking if anyone else wants to make a bid. When the bidding is closed, we have then identified the two highest bidders. We then continue the auction between these two bidders to determine who gets first choice. The reason for doing this is that both bidders should not have to pay for first choice, only the winning bidder. In the Japanese auction, all bidders who participate are making the same bid so there is no need to differentiate a first and second highest bid. The ultimate second-highest bidder pays the price at which only two bidders remain while the ultimate high bidder pays the price at which only he or she remains.

only if the top two national bids both exceed the sum of the top regional bids.<sup>7</sup> (The high bidder would get first choice.) If two national bids do not both exceed the sum of the highest regional bids then one national license would be awarded if the highest national bid exceeds the sum of the second-highest regional bids. The winning national bidder would get first choice if this winning bid exceeds the sum of the first-highest regional bids; otherwise, the national bidder would get the second-choice in each region.

To summarize, we believe that the current sequential auction procedure of A and B spectrum will tax the decision-making ability of even the most sophisticated bidders. Combining the two bandwidths into one auction will make the bidding simpler. It will allow firms to focus attention on the more important bidding elements. It will prevent inefficient outcomes because of the reduced role for strategic bidding. The recommended procedure is also simpler and quicker for the FCC since it reduces the numbers of auctions from seven to four.

## **2. Fairness and 3. Efficiency**

The design of the auction should put all bidders on a level playing field. This is important for efficiency reasons --- we do not want to disadvantage the bidder with the highest valuation. It is also important as a matter of fairness.<sup>8</sup>

The proposed auction rules disadvantages bidders with cellular licenses, especially those who seek to create a national network. We believe that we can eliminate these artificial handicaps without compromising any of the other stated objectives.

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<sup>7</sup> The above mechanism does not guarantee an efficient allocation. The FCC will have to consider whether they would prefer an efficient allocation mechanism at the price of additional complexity. See discussion in Appendix B for characterization of an efficient allocation mechanism.

<sup>8</sup> Although this principle may seem obvious, it may be in conflict with revenue maximization. If the intent of the auction design is to maximize revenue, then results from McAfee and McMillan (1987) show that placing the strongest bidders at a disadvantage may increase the total expected revenue. (This may also require limits on the transferability of licenses. Otherwise the asymmetries will not result in more revenue to the government but rather they will be a windfall gain to advantaged bidders who will then sell the licenses ex post to the most efficient firms.) These asymmetries allow inefficient firms to win the auction. We reject this approach for two reasons. The auction authorization explicitly states that the design should not be based on revenue maximization. We should not introduce inefficiencies into the system because it could stimulate bidding. We are interested in having the finest communications system. Consumers will lose unless the most efficient firms have a fair chance of winning the auction.

### ***The Current Eligibility Restrictions Disadvantages Firms with Cellular licenses.***

Because of the potential to be misunderstood, let us emphasize the point: *this is not a proposal to change the eligibility restrictions to own and operate a PCS license.* We want to draw an important distinction between the eligibility to hold a license and the eligibility to bid. The commission may decide to uphold restrictions on cellular phone companies regarding their ability to hold PCS licenses in regions in which they have significant cellular interests.<sup>9</sup> This, however, should not eliminate them from the bidding competition. The point is to allow firms to bid for a national license (or regional network) and then having won the PCS license, resolve the source of conflict. One should not presume that a firm that is presently ineligible for a PCS license will not be able to resolve this conflict after the auction.

### **Proposal 2. Allow firms to bid even if they presently have a cellular conflict.**

Firms should be allowed to bid recognizing that they can only operate the PCS license if they divest their cellular interest. Allow firms to resolve their conflict after the auction, not before.<sup>10</sup> Allowing firms with cellular licenses to bid within region should have no effect on the ex-post competitiveness of the market. We are not at this time asking to change the rules for eligibility to *operate* a PCS. The problem is that under the current rules, firms that are not presently eligible to operate a license also appear to be ineligible to bid.

Allowing the largest universe of potential bidders helps maximize the efficiency of the auction as an allocation device. Excluding firms with cellular interests from bidding will greatly reduce the competition of the auction. This is especially pronounced for firms interested in bidding for a national network. *It is an undue burden to ask a firm to sell its*

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<sup>9</sup> There are also reasons to reconsider the eligibility rules for operating a PCS license, but we do not address this issue here.

<sup>10</sup> Based on post-auction market prices of cellular licenses, they would also have the option of selling the PCS license. The FCC could give firms with such a conflict a reasonable time to sell either their cellular or their PCS license. Firms will be bidding on PCS licenses without knowing the ex-post value of cellular. Once the auction is over and there are ex post markets for both cellular and PCS licenses it is reasonable to demand that a firm make up its mind and sell *one of the two properties*. Given the forced buildout rule, firms have no incentive to buy a license and hold it --- this would result in forfeiting an extremely valuable license. There is no reason to speculate since no one is excluded from bidding. There is no one to sell to who wasn't at the auction.

*cellular licenses on the hope or possibility that it will win a PCS license. Firms that might ultimately prefer a PCS license to cellular are placed in an untenable position.*

There are several advantages of this approach. It allows firms with cellular licenses to participate in the PCS auction. If these firms are the best positioned to develop the PCS technology, consumers will benefit if they win the auction. Opening up eligibility will promote the most efficient allocation of licenses. It will also make the post-auction market more competitive. Firms can realistically consider the option of selling some of their cellular interests and moving into PCS. This is exactly the type of competition that the FCC wants to promote. This effect would be further amplified if the RBOC companies are the best positioned to develop the PCS technology.

Opening the eligibility for bidding will also help defeat speculation. Opening up the PCS auction to as many people as possible will generate the highest possible initial prices for the FCC and therefore make the potential profits from speculation as low as possible. If entry to the initial auction is limited, there is the possibility that someone who is a potential buyer may decide to speculate on the possibility of selling later to someone who is not eligible to buy now. Under the current eligibility rules, people have a speculative reason to buy the license and then trade later with firms that are presently ineligible to bid, but might choose to divest ex-post of cellular and purchase a PCS license based on the post-auction market prices.

Opening up eligibility promotes efficiency and defeats speculation. It is also the fairest approach. No one is advantaged or disadvantaged based on their current market position. Everyone has the same rules for operating a PCS license and having agreed to those rules they are allowed to bid.

#### **4. Increase Information, Discourage Irrationality and**

#### **5. Eliminate Incentive to Manipulate Bidding or Default.**

### ***Auction Safeguards***

At this point we turn to consider proposals that help prevent things from going wrong. It is our view that rerunning an auction would be an extremely costly event. All the bids are interrelated. The value of a license depends on what other licenses you have. If a firm defaults on one of its bids, this could have a large and disruptive effect on the entire auction process. For this reason, we should go to great lengths to find elements of the auction design that protect us from defaults. Certainly requiring a significant and forfeitable deposit is a step in this direction. But we can only go so far without being overly burdensome. Thus we turn to the issue of protecting the auction against a default and manipulative bidding.

One problem with an open English auction is that it is susceptible to manipulative bidding. It is possible for a bidding ring or even two bidders to rapidly escalate the bids and then default. For example, bidder 1 offers 1 million and then bidder 2 offers 50 million. If the 50 million defaults, the auctioneer can not return to the 1 million bid since this is an artificially low number. People who would have bid in the interval never had a chance to do so. It is for this reason that we believe the FCC intends to rerun the auction in the event of a default.

There is a possibility that a winning bidder might intentionally default on its bid. This will lead to great confusion and potential lawsuits. It will also disrupt all the subsequent regional bidding. The value that firms place on regional licenses will depend on the assignment of the largest MTAs. If there were a default on one of these licenses it would cause firms to reevaluate all of their bidding. If there were a procedure that would avoid having to run a second auction in the event of a default, it would be most desirable not to have to do so.

In the proposed sealed bidding for national licenses this type of manipulation is not possible so there would be no need to run the auction again. With sealed bidding, no one is able to artificially depress the size of the losing bid. That is because people cannot be

not blocked out from making bids. Thus in the event of a default, we could go to the next highest bid.

There are solutions to this manipulation problem even under the open English bidding system. One solution is to limit the price increase to prespecified units not to exceed some amount. Thus bidders can increase by amounts up to \$200,000. This would stop someone from preemptive bidding. It would also allow more bidders to participate in the auction.

A second solution to this problem still under the English auction is to allow backup bidding after the auction. Firms could place "losing" bids after the auction is over. If one firm wins at 50 million, the auctioneer then announces that he or she will now entertain losing bids. If you believe that this price is too high and that the winner will forfeit, you can bid 20 million or any other number. These bids could be made in a sealed envelope. (The auction is over --- even if you bid more than 50 million you do not win unless the person defaults.) In the event of a default, the license is then awarded to the highest losing bidder taking into account all the bids made during the auction and the backup bids. In this way, nobody is denied a chance to bid because the price escalated too quickly. Collusion can not create an artificially low losing bid. In the event of a default, there will be no need to run a second auction.<sup>11</sup>

Our most preferred solution to the manipulation and default problem is to use a different form of an open auction. The Commission could use a Japanese auction. A Japanese auction is similar to an English auction in that bidding is open. As described earlier, instead of asking for a person to bid as in "I hear 10, do I hear 20?..." the auctioneer asks all parties who are willing to pay the current price to raise their hand. The auctioneer then continues to raise the price until only 2 hands are left (in the event of selling 2 licenses). *Once a hand is dropped, it cannot be raised again.* A Japanese auction is just like an English auction except that you know how many bidders are left in the competition. Thus one immediate advantage is that you cannot block someone out of the bidding competition through a rapid escalation of bids. In the event of a default, the identify of

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<sup>11</sup> We believe that this is one of those safeguards that once in place will never have to be used. Firms will realize that with this safeguard in place there is no advantage to placing a bid on which they plan to default and therefore the post-auction bidding will be short. The best type of safeguards are the ones that never need to be used in equilibrium.

the next highest bidder is clear. Another advantage of the Japanese auction is that it provides better information transmission and thus helps mitigate the winner's curse.

**Proposal 3. Use a Japanese Auction in the MTA and BTA Bidding.**

The FCC has been encouraged to explore experimental auction designs. Running any auction of this magnitude will itself be an experiment and the simplicity of the proposed rules are a virtue. There is also a theoretical advantage of the Japanese auction: it helps reduce the winner's curse (see Appendix A). Since there is a common value element associated with the PCS license, bidders will have to deal with the potential for a winner's curse. The person who wins the auction will be the one who had an excessively optimistic view of its worth. To avoid the winner's curse, it helps to have as much information as possible about the valuations of other bidders.

The point of this proposal is to provide each bidder with the most information regarding how many other firms are willing to go this far. With better information, there is less concern about a winner's curse and therefore an incentive to bid higher. The theoretical auction literature predicts that the Commission will raise more revenue using a Japanese bidding format compared to the English format. It is worth paying a little extra in order to have better information. We seek to reduce the uncertainty associated with the bidding. It is also important to us to help prevent irrational bidding. It will not help the telecommunications industry to have someone wildly overbid only to either default or go bankrupt because they overpaid. Bidding in these auctions will be an extremely complicated task for all parties. More information will make everyone's task easier and help maintain rationality in this process.

Another advantage of the Japanese auction is that it makes it easier to implement Proposal 1, that we combine the two 30 MHz licenses into one auction (and three 10 MHz into one auction). In a Japanese auction there is no issue of who has the highest and who has the second-highest bid. Everyone who is participating is making the same bid. Thus, in the case of the 30 MHz licenses, the price of the second choice license is determined by the point where only two bidders remain in the auction. The auction can then continue with these two bidders until one drops out. This determines the price paid for getting first choice. Note that the person who drops out does not pay this last price. He or she lost the competition for first choice. The price paid for second choice was already determined by the point at which only two bidders remained in the auction.



Japanese bidding has great potential to improve the auction performance. It is remarkable that this subtle change in the open bidding format helps implement the proposal to combine auctions, reduces the winner's curse, increases government revenue, and eliminates certain incentives for collusive and disruptive bidding.

### ***Minor Points***

#### ***Combinatorial Bidding on the 10 MHz licenses***

Analogous to the proposed sealed bids for the national 30 MHz licenses, we believe that firms should have an opportunity to make sealed bids for national and or MTA 10 MHz licenses. In this discussion, we are assuming that the above proposal for selling the three licenses in one auction will be adopted. Parallel to the proposal for 30 MHz licenses, if the sum of the lowest winning bids is exceeded by a regional bid, the MTA bid wins. A national bids trumps the combination of regional and BTA bids if it is higher still. A firm could also bid for 20 MHz of this spectrum and this would be equivalent to requiring that it have two winning 10 MHz bids. The advantages of combining 10 MHz BTA licenses into an MTA license are similar to the arguments for permitting combinatorial bidding for national licenses in the 30 MHz bands and we do not repeat them here.

**Proposal 4. Allow National and MTA bidding for 10 MHz BTA licenses.**

### ***Announce Identity of Winning Bidders***

It is our presumption that the identity of the winning bidders in each auction will be announced prior to the next regional MTA auction. This is in the spirit of the Japanese auction; provide useful information when possible. The weight that other bidders place on the winning value will depend on the identity of the winning bidder.

### ***Order of MTA Auctions***

We agree that the preferred order of the regional auctions is from large to small. Ownership of the most populated MTAs will determine the viability of creating a national network in the series of regional auctions. Firms will then have to choose between a regional and a national strategy.

There are two costs associated with this approach. Firms that win the big MTAs (or big BTAs) will be in an asymmetric position compared to other bidders. They may be better off because of their ability to form a national network; they may be worse off because they have exhausted their budget. If the asymmetry is to their advantage, then bidding will be even more competitive for the first licenses because of the advantage it confers in subsequent auctions. Reversing the order of the auction creates its own problems. Not knowing if you have the essential MTAs to form a national network created too much uncertainty in the early regional bidding. It reduces your flexibility to change strategy as the auction progresses. Therefore, the proposed sequence of big to little is desirable.

We have one minor variation that might be considered. Perhaps the first auction should be an average MTA and then we could move to the biggest ones. Because the auction of a New York or California MTA will be very significant, it might help if bidders have at least one opportunity to bid for an average case before going for the most competitive cases. Should bidders' first experience with the auction bidding be for a New York license?

### ***Moves in the Wrong Direction***

At this point, we have discussed our proposals regarding the auction design. It may prove helpful to provide a brief discussion of one change in the auction design that we believe would move in the wrong direction.

*Do not have a second round of bidding after all the regional auctions (and the national bids are announced).* There is great virtue in knowing that a bid is final. Who would be allowed to bid in the second round of the auction? Would only the winners get to bid? It is conceivable to us that someone could design a workable system with several rounds of bidding but we have not seen such an example. Having several rounds of bidding is not

only more confusing, it also puts national bidders at a disadvantage. If they bid too low, they lose. If they bid just right, they get outbid ex post in the second round of the regional bidding. If the national bidders bid too high, they win the auction but they lose money. They can't win, so they don't bid and that hurts the fairness and efficiency of the auction as an allocation device.

## APPENDIX A:

### ***A REVIEW OF AUCTION THEORY AND THE WINNER'S CURSE***

#### ***Four Major Types of Auctions***

Four basic types of auctions are widely used: the English auction (also called the open, oral, or ascending bid auction); the descending bid auction (used in the sale of flowers in the Netherlands and called the Dutch auction by economists); the first price sealed bid auction; and the second price sealed bid auction (called the Vickrey auction by economists and, confusingly, called the Dutch auction by investment bankers).

In the *English* auction, the price is successively raised until only one bidder remains. This can be done by having the seller announce prices, or by having the bidders call out prices themselves, or by having bids submitted electronically with the best current bid posted. Antiques and artwork are two examples of goods commonly sold using the English auction, but houses in Melbourne, Australia are sold this way, too.

One version of the English auction is called the "*Japanese auction*," and this is the type most commonly studied by auction theorists (see, e.g., Milgrom and Weber (1982)). In this version, the auctioneer calls out a continuous series of rising prices. All bidders start in the auction and may quit at any time. At each price, all bidders that are willing to pay this price signal this indication, whether through a raised bidding card or electronically. Once someone quits, he or she is not let back in. Thus, instead of asking for a person to bid as in "I hear 10, do I hear 20?..." the auctioneer asks all parties who are willing to pay the current price to raise their bidding card. The auctioneer then continues to raise the price until only 2 bidders are left (in the event of selling 2 licenses). *Once a bidder drops out, he or she cannot reenter.* As we show below, this auction design is particularly helpful in dealing with the winner's curse. Among other advantages, there is no possibility for one bidder to preempt the process by making a large "jump bid."<sup>12</sup>

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<sup>12</sup> A jump bid occurs when someone increases the high bid by more than the bidding increment. Thus there is a jump bid if the high bid progresses from 6.2 million to 6.3 million to 6.4 millions to 11 million. The problem with jump bids is that it moves the bidding away from an open English style auction and closer to a first-price sealed-bid auction. This increases the consequences of the winner's curse because the jump bid effectively hides information regarding the true value of the second-highest bidder. It also creates

The descending bid auction works in just the opposite way from the English auction. For example, in the Dutch flowers auctions, the potential buyers all sit in a room at desks with buzzers connected to an electronic clock at the front of the room. The interior of the clock has information about what is being sold and the price at which the auction starts. Once the auction begins, a series of lights around the edge of the clock indicate to what percentage of the original asking price the good has fallen. As soon as one bidder buzzes in, he or she gets the flowers at the price indicated on the clock. (If there are several lots of the same flowers from the same seller available that morning, the buyer can choose to buy only some of the available lots, and the rest will be re-auctioned.) Fish are sold this way in Israel, as is tobacco in Canada.

In the first-price sealed-bid auction all bidders submit one bid, without being able to observe what their competitors are bidding. The highest bidder wins, and pays the amount of his bid. First-price sealed-bid auctions are used in auctioning mineral rights to U.S. government-owned land; they are also sometimes used in the sales of artwork and real estate. This method is also often used in government procurement at both the local and federal level. Most U.S. Treasury securities are sold through the multi-unit equivalent of the first-price auction, though recently the Treasury has been experimenting with the sealed-bid second-price auction.<sup>13</sup>

In the second-price sealed bid auction, bidders submit sealed bids having been told that the best bid(s) will win, but the winner(s) will pay the best losing bid. An example of where this method is being used in the broadcast industry is the current offer of Capital Cities/ABC to buy up to 2 million shares of their stock at a price between \$590 and \$630. Each stockholder has the right to tender some or all of his stock at any price between \$590 and \$630. The 2 million shares offered at the lowest price will be accepted, but each seller will receive the same price. For example, if 1.8 million shares are tendered at prices below \$600 and 400,000 shares are tendered at exactly \$600, then the company will buy

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the possibility of an inefficient auction outcome. A discussion of the consequences of jump bids is presented in Avery (1993).

<sup>13</sup> Feldman and Mehra (1993) note that in parts of the financial community the first price auction is called the English auction, again in contrast to the academic terminology, and that in the United Kingdom this type of auction is called an American auction. For articles that discuss multi-unit auctions, see Wilson (1979), Harris and Raviv (1981), Maskin and Riley (1983), Milgrom (1985), and Bulow and Klemperer (1994).

all shares offered for less than \$600 and half of the shares offered at \$600, paying \$600 for every share purchased.

### ***The Revenue Equivalence Theorem***

The early auctions literature (e.g. Vickery (1961), Riley and Samuelson (1981), and Myerson (1981)) shows that under three basic assumptions all four types of auctions yield sellers the same expected revenue. These assumptions are (1) that bidders have private, independent values for the good being auctioned, (2) bidders are risk-neutral, (3) bidders are symmetric, with that their values drawn from identically distributed distributions. Bulow and Klemperer (1993) show that revenue equivalence holds for common value auctions and auctions that are partially common and partially private as well, so long as the “signal” that each bidder has about the common value is independent of the signal that the other bidders have. Why does this unexpected revenue equivalence result occur?

We begin by examining the optimal bidding strategies in each auction. In the second-price auction, it is in every bidder's interest to bid his or her true value. Imagine that your value is 100 and the highest bid of all the other bidders is  $X$ . If  $X$  is less than 100 and you bid 100, you will win the auction and pay  $X$ . Bidding less than 100 would not affect anything as long as you bid more than  $X$ : you would still win and pay  $X$ . But bidding below 100 could cost you your profit of  $100 - X$  if by mistake you bid less than  $X$ . If  $X$  is above 100, then you don't want to win the auction. It would cost more than the item is worth. Thus there is no gain from bidding more than 100. No matter what others bid, you want to bid 100. You can only be hurt by bidding an amount other than your true value and never helped. This implies that the winner will be the person with the highest value, and the price the winner pays will be the second-highest valuation.

The English auction leads to the exact same result. The winner will be the person who has the highest value, and the price the winner pays will be the price at which the person with the second-highest value drops out. Since it does not make sense to drop out until one's value is reached and it does not make sense to stay in past that point, the auction will stop when the price reaches the value of the second-highest participant.<sup>14</sup>

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<sup>14</sup> If the auction requires minimum bidding increments, the theory predicts that the price will be the same as in the sealed bid second price auction, within a bidding increment.

The descending-bid auction and the first-price sealed-bid auction are also strategically equivalent. Think of each person in the descending-bid auction writing down on a piece of paper the price at which he or she will buzz in. In this case, the descending-bid auction is just like a sealed-bid first-price auction. The buzz-in point is the equivalent of making a sealed bid. One might think, though, that because you do not have to choose the price at which you would jump in the descending bid auction, this would make a difference. The fact that no one has buzzed in before you will reduce the expected price of the object to be sold by the time the price falls to the price at which you were planning to bid, so why wouldn't you want to revise downwards your initially optimal jump-in price? The reason is that when you formulate your initial bid the proper framework is to ask "will I want to jump in at this price if no one has jumped in before?" If someone does jump in earlier, your strategy becomes moot. So the price that you would choose in advance of the auction is the one for which it makes sense for you to jump in contingent on no one having jumped in earlier.

Consider someone with a value of 100 thinking whether to bid 99 or 98 in a sealed bid auction. The thought process is: if anyone has bid more than 99, I lose anyway, regardless of what I decide. So I might as well make my decision on the assumption that no one will bid more than 99. Conditional on no one bidding above 99, I can get a sure profit of 1 by bidding 99, or a possible profit of 2, which I will only earn if no one bids between 98 and 99. Conditional on deciding that 98 is a better bid than 99, the next decision is whether 97 is better than 98. This decision can be made conditional on no one else bidding more than 98. This logic continues until the bid that maximizes expected profit is reached. The analysis in the descending bid auction is made in just the same way. The only difference is that when the price falls to 98, say, the bidder is absolutely sure that no one will bid more than 98. But in deciding whether to bid 98 or wait at least until 97, the bidder in the descending bid auction makes the exact same calculation as the bidder in the first price auction, who can be thought of as making this comparison conditional on there being no one bidding more than 98.

More complicated is the final link between the first price sealed bid auction and the English or second price auction. In the first price auction, all participants should bid the amount they would expect to pay contingent on winning the second price auction. Thus the *expected* winning bid is the same. To show why this is an optimal bidding strategy, assume that there are two bidders who each have values drawn uniformly between 0 and

100, and your value is 60. In an English auction, you would win whenever your competitor had a value below 60. On average when your competitor was below 60, his or her value would be 30, so your expected profit would be 30 times the 60 percent likelihood that your competitor's value would be below yours, making your expected profit 30 times .60, or 18. For the revenue equivalence theorem to hold, it must be optimal for this bidder to bid the average of all the values below 60, or 30, in the first-price auction. Imagine a bidder in the first price auction gets greedy and decides to shade a bid while all the other bidders continue following their equilibrium strategy. For example, the bidder chooses to bid only 25, the average of all the underbids between 0 and 50, which means he or she will only win the auction if the competitor who is following the equilibrium strategy has a value of less than 50, which will occur with probability .50. Then the expected profit of the "greedy" bidder will be his or her value minus the bid times the probability of winning the auction,  $(60 - 25) * .50$ , or 17.50. The bidder's loss in expected profits would be exactly equal to the value, 60, minus the average value of the underbidder in the cases in which the bidder "should" have won ---  $1/2 * (50 + 60) = 55$  --- multiplied by the probability that the underbidder will have a value in this region, which is 10 percent. This logic carries through quite generally. For a graphical proof of the Revenue Equivalence Theorem, see Bulow and Roberts (1989).

### ***Common Values and the Winner's Curse***

A common value model is one in which all bidders would have the same value for a good if they had the same information. For example, assume that three bidders are each equally adept at estimating the value of an asset. If they could share information, each would make a revised estimate equal to the average of the three different estimates. Let one estimate a value of 75, one a value of 100, and one a value of 125; if the three bidders could share information, they would all revise their valuation estimates to  $1/3 * (75 + 100 + 125) = 100$ . But when each bidder is preparing to bid, he or she does not know the estimates of the other bidders. How does the common value element affect the bidding? In equilibrium, each bidder knows that he or she will win the auction (regardless of the type of auction, but consider for concreteness the first-price sealed-bid auction) only when theirs is the most optimistic of the three valuation estimates. Therefore, conditional on being the winner of the auction you know you were basing your bid on an overly optimistic assessment of the property's value. This is the "winner's curse." To counteract the winner's curse, each bidder will shade down his or her bid, estimating the value of the property not as his or her own estimate of the value, but the best guess of the average of



the three values, contingent on one's own estimate of the value being greater than or equal to the other two. You need not worry about the overly negative effect on your bid when you do not have the highest value estimate. If your estimate is below that of one or more other bidders, you will lose in the bidding competition and it will not matter what you bid. You should always should base your bidding strategy on the assumption that your estimate is greater than or equal to that of anyone else.<sup>15</sup>

### ***Affiliation***

What does affiliation mean economically? The assumption is as follows: imagine that the value estimate of person X is greater than that of person Y. Now they are each told that there is a third person Z who has a value estimate which is in the range between two amounts L and H. They are then asked to guess the probability that this third person's value is between some intermediate value M and H, rather than between L and M. If the value estimates of the bidders are affiliated, regardless of the values of X, Y, L, M, and H person X will assign at least as high a probability to the third person being between M and H as will person Y, and perhaps higher. Furthermore, affiliation implies that if both X and Y were told the valuation of any fourth person A, then it would remain the case, regardless of what A's valuation was, that X would still assign a higher probability to Z having a value in the M to H range rather than the L to M range than would Y.

### ***Effect of Affiliated Values on the Expected Returns from Auctions:***

#### ***Why the Japanese Auction Outperforms Other Auctions.***

While the descending-bid and first-price sealed-bid auctions remain equivalent with affiliation, they both become inferior to the sealed-bid second-price auction and the Japanese auction. This is true regardless of whether the bidders have private values or common values.<sup>16</sup>

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<sup>15</sup> As Bulow and Klemperer (1993) show, as long as bidder value estimates are independent, then revenue equivalence will still hold, but as Milgrom and Weber (1981) show, if bidder valuations are affiliated then revenue equivalence breaks down.

<sup>16</sup> An example of a private value auction with affiliated values would be one where two people with a personal fondness for plaid suits were bidding against each other for one in an auction. Each might know what the suit is worth to him, regardless of the valuation of the other bidder, but the higher his own value then the higher his estimate of what the suit is worth to the other bidder.